A higher percentage of lightning bolts was also reported as striking the ground in 1925 as compared to 1924, the figures being 34 per cent and 30 per cent, respectively.

For the region as a whole, about 23 per cent of the lightning storms are first seen in the morning, the Selway-Nezperce group showing the highest per cent, and the Bitterroot-Missoula the lowest. Only 4 per cent of the storms last through midnight, and only 47 per cent pass directly over the lookouts.

About 6 storms out of 10 appear to be safe, and about 4 out of 10, fire-starters. Subdivisions of the district showed marked differences in this respect, the eastern Montana forests having a ratio of about 9 safe to 1 dangerous storm, and the Idaho forests a ratio of 1 to 1.

Usually the first day or two of a wave of lightning storms brings the greatest percentage of fires, the following storm days being less dangerous.

About 88 per cent of the lightning storms in this region travel toward the north, northeast, east, or southeast. Sixty-six per cent go northeast or east.

The time elapsing between first sighting a lightning storm and the discovery of the fires caused by it offers a very material warning period in which to prepare for the impending danger. About 56 per cent of the first discoveries will be made within five hours after first sighting the storm, that period being available to prepare for 44 per cent of the first discoveries, 49 per cent of the second, 54 per cent of the third, and 59 per cent of the fourth discoveries. Nine per cent of the first discoveries are not made till more than 48 hours after the storm is first seen, and of all those not discovered till after 48 hours 43 per cent are first discoveries, not preceded by any other fires. Among the subdivisions of the district there are marked differences in the speed of discovery of the first fire, and in the percentage of fires not discovered till after 48 hours. The Bitterroot-Missoula group shows the quickest discovery of the first fires, whereas the other western Montana forests show the greatest elapsed time in this respect, as well as the highest percentage of fires not found for more than 48 hours after the storm was first seen.

## THE JANUARY STORMS OVER THE NORTH ALANTIC AND THE STROPHS OF THE GREENLAND ANTICYCLONE

551.515 (261.1) (988)

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The exceptional severity of the storms in January, 1925, over the North Atlantic has been brought home to us through the loss of a number of vessels, including the *Antinoe* after her crew had been rescued by the *President Roosevelt*. Sir Napier Shaw in an article published in the London Times of February 6 drew attention to the close parallel between the atmospheric conditions over the Atlantic last January and during the famous storms of the winter of 1898 and 1899 (*1*).

In each case there developed a vast depression within the atmosphere in the area south of Greenland—an area with a diameter of about 2,000 miles from which there had been removed, according to computations, about two million million tons of air.

The present writer was so struck by the peculiar twin depressions which followed each other during the closing week of last January that the possibility occurred to him of establishing a connection in time between the storm depressions over the Atlantic and the outrushes of cold air from the inland ice of Greenland (*2*).

Study of the recorded observations (*3*) upon wind force and direction at the Greenland weather stations had already indicated that the wind from the inland ice seldom reached hurricane velocity at these stations due to overriding in the lee of the steep marginal slope of the glacier (*4*). To this general rule there appeared, however, to be partial exceptions in the cases of the Danish stations of Angmagsalik on the southeast coast and of Nanortalik on the south coast. These stations are farther removed than the others from the margin of the glacier, and for this reason they feel the strophs of the anticyclone during the winter season, though hardly with their full intensity. At Angmagsalik, where the station is distant 60 miles from the ice margin, the winds blowing down off the glacier arrive from the northerly or northeasterly quarter. In this vicinity the inland ice pushes far out to the eastward and northeastward of the station on its northern side, and the slope winds which start radially outward from the interior are deviated to the right by earth rotation and as a consequence reach the station coming as a rule from the north or northeast.

Through the courtesy of Dr. D. La Cour, Director of the Meteorological Institute at Copenhagen, the writer has obtained the radio reports upon wind force and direction at Angmagsalik for the month of January and the first half of February.[1]

For the month of January these data are as follows, the strophs being inclosed in boxes:

TABLE 1.—*Wind force and direction at Angmagsalik, January, 1926*

| Date | Wind direction | Wind force (Beaufort) | Date | Wind direction | Wind force (Beaufort) |
|---|---|---|---|---|---|
| Jan. 1 | | 0 | Jan. 16 | SW | 1 |
| 2 | NE | 3 | 17 | S | 1 |
| 3 | NE | 9 | 18 | | 0 |
| 4 | W | 1 | 19 | NW | 1 |
| 5 | N | 3 | 20 | N | 1 |
| 6 | N | 6 | 21 | | 0 |
| 7 | SE | 1 | 22 | W | 1 |
| 8 | W | 1 | 23 | NE | 5 |
| 9 | S | 6 | 24 | NE | 9 |
| 10 | SW | 1 | 25 | E | 1 |
| 11 | SW | 2 | 26 | N | 5 |
| 12 | E | 2 | 27 | NE | 9 |
| 13 | S | 2 | 28 | | 0 |
| 14 | W | 1 | 29 | N | 2 |
| 15 | SE | 2 | 30 | S | 3 |
| | | | 31 | E | 1 |

From these data it appears that there were during the month of January four strophs from the glacial anticyclone, and these are grouped in a twin relation with a 24-hour interval which is valuable for purposes of identification. Dr. George C. Simpson, head of the British Meteorological Office, has kindly furnished the writer with copies of the synoptic weather charts for the northeastern Atlantic and western Europe for the month of January, and from these it appears that marked atmospheric minima were centered in the general region lying south of Greenland upon the following dates:

[1] These, it appears, are regularly issued in the Icelandic weather bulletins sent out by "Vedurstofan," Reykjavik.

TABLE 2.—*Pronounced atmospheric minima south of Greenland, January, 1926*

| Day and hour | Air pressure in millibars at center | Approximate position of center | |
|---|---|---|---|
| | | Latitude | Longitude |
| | | ° | ° |
| Jan. 5[18] | 968 | 60 N. | 30 W. |
| 6[7] | 972 | 60 N. | 30 W. |
| 9[18] | 968 | 55 N. | 40 W. |
| 10[7] | 956 | 55 N. | 30 W. |
| 24[18] | 968 | 55 N. | 30 W. |
| 26[7] | 968 | 55 N. | 30 W. |
| 28[7] | 964 | 55 N. | 30 W. |
| Feb. 1[7] | 952 | 55 N. | 25 W. |

TABLE 3.—*Wind force and direction at Angmagsalik, February 1–15, 1926*

| Day | Wind direction | Wind force (Beaufort) |
|---|---|---|
| Feb. 1 | SW | 2 |
| 2 | SE | 4 |
| 3 | | 0 |
| 4 | E | 3 |
| 5 | NE | 5 |
| 6 | SW | 1 |
| 7 | | 0 |
| 8 | N | 2 |
| 9 | NE | 1 |
| 10 | S | 1 |
| 11 | | 0 |
| 12 | SW | 1 |
| 13 | NE | 5 |
| 14 | E | 10 |
| 15 | NE | 5 |

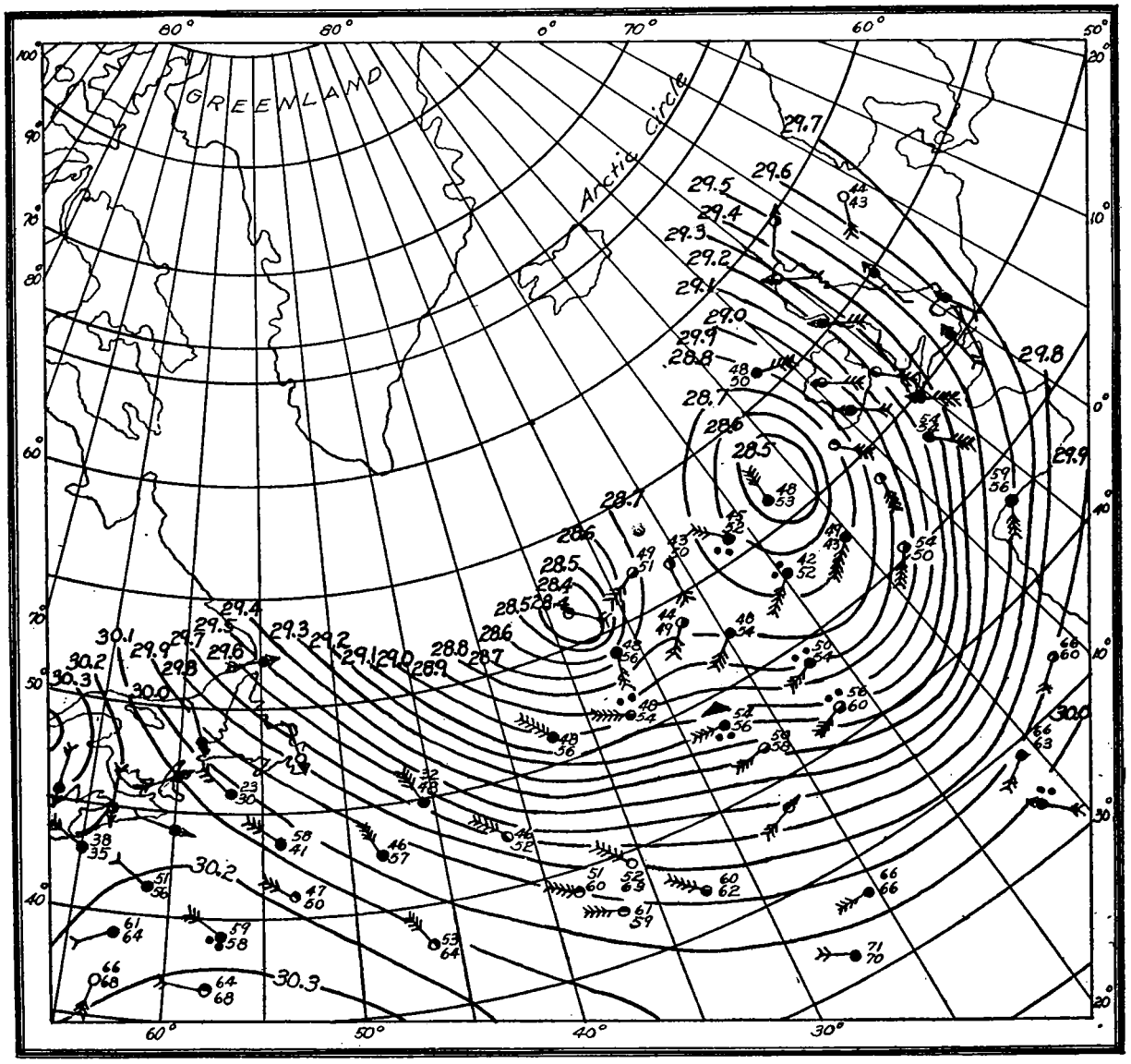


FIG. 1.—Isobaric chart for the northern Atlantic for January 31 (after Young in MONTHLY WEATHER REVIEW)

The twin relations of the strophs from Greenland appear to be confirmed therefore in the storms upon the Atlantic, but with some widening of the interval, as might be expected. A map of the conditions over the North Atlantic on the 31st of January is reproduced from the MONTHLY WEATHER REVIEW in Figure 1. (*5*)

The data concerning the strophs from the Greenland anticyclone during the first half of the month of February are now available from the station of Angmagsalik. They are as follows:

Study of the synoptic charts for the North Atlantic shows that there were during February no storms comparable with those of January, with the exception perhaps of that which began on the evening of the 15th, the depression of which was located to the southward of Iceland and was represented by a pressure near its center of 972 millibars. This depression remained nearly stationary till the evening of the 17th. Lesser storms occurred within a depression centered near latitude 55° N. and longitude 35° W. between the 9th and

12th, where the pressure varied from 988 to 980 millibars.

On the basis of all the above data the following table has been constructed:

TABLE 4.—*Greenland strophs and Atlantic storms, January 1 to February 15, 1926*

| Greenland strophs | | Minima of Atlantic storms | |
|---|---|---|---|
| Date | Wind force | Date | Minima |
| Jan. 2–3 | 3–9 | Jan. 5–6 | 968–972 |
| Jan. 5–6 | 3–6 | Jan. 9–10 | 968–956 |
| Jan. 23–24 | 5–9 | Jan. 24–26 | 968–968 |
| Jan. 26–27 | 5–9 | Jan. 28–Feb. 1 | 964–952 |
| Feb. 4–5 | 3–5 | Feb. 9–12 | 988–980 |
| Feb. 13–14 | 5–10 | Feb. 14–17 | 972–976 |

It thus appears that for January and the first part of February of the present year the strophs from the Greenland anticyclone were felt at Angmagsalik even near the level of the sea from two to five days before the great storms culminated over the North Atlantic within the area between latitude 50° and 60° N., and longitude 20° and 30° W. It is further to be noted that in nearly all cases these outrushes of cold air from the inland-ice of Greenland, developed gradually but ended abruptly, as is the rule and a consequence of the known conditions of their development.

Similar relationships are indicated for the year 1922 between the winter storms, but for these only, and the D and E cyclones as these have been determined by Bjerknes and Solberg. (*6*) The times of arrival of these cyclones on the meridians of 10° W. (Jan Mayen) and Greenwich for that year have been kindly furnished the writer by Prof. V. Bjerknes of Oslo. In addition to the Angmagsalik data those of Nanortalik near the southern extremity of Greenland have been added, and those also from Mygbukten (Mackenzie Bay), the temporary weather station on Franz Joseph Fjord, eastern Greenland. These latter have been furnished by Director O. Krogness of the Meteorological Institute at Trondhjem. At Nanortalik the foehn winds blow off the inland-ice from the northwesterly quarter, whereas at Mygbukten they come from the north and northwest. The data for the year 1922 are set forth in tabular form in table 5.

It is clearly evident from all the above that the data derived from weather stations which are located near sea level on the coast of Greenland are inadequate for a proper forecasting of Atlantic storms, but they none the less hold out the promise that with stations located at altitudes above 1,000 meters, at which level the overriding is largely localized, something more satisfactory will be possible.

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TABLE 5.—*Strophs of the Greenland anticyclone as recorded at Angmagsalik, Nanortalik, and Mygbugten, compared with the time of arrival of centers of D and E cyclones at longitude 10° W. during 1922*

| Strophs of anticyclone | | | D and E cyclones | | |
|---|---|---|---|---|---|
| Date | Wind force | Station [1] | Number | Day and hour | |
| | | | | 10° W. | 0° |
| Jan. 1–2 | 4–7 | A | | | |
| Jan. 6–9 | 6–9 | N | 1D | $9^{19}$ | $10^{0}$ |
| Jan. 12 | 8 | N | | | |
| Jan. 14–15 | 6–9 | N | 3D | $20^{6}$ | |
| Jan. 23–25 | 6–7 | A | 4D | $25^{14}$ | |
| | | | 5D | | $3^{14}$ |
| | | | 5E | $4^{19}$ | |
| | | | 6D | $8^{6}$ | $8^{14}$ |
| Feb. 6–8 | 6–8 | A., N. | 7D | $12^{0}$ | $12^{14}$ |
| | | | 7E | $13^{0}$ | $13^{14}$ |
| Feb. 14 | 7–9 | A | 8D | $16^{19}$ | $17^{6}$ |
| Feb. 15–16 | 6–8 | N | | | |
| Feb. 16–17 | 5–8 | A | | | |
| Feb. 18–19 | 6–7 | N | 9D | | $24^{6}$ |
| Feb. 22–23 | 7–9 | A | 10E | $27^{14}$ | |
| Mar. 2–4 | 6 | N | 11D | $5^{14}$ | |
| Mar. 2–5 | 6–9 | A | 11E | | $7^{6}$ |
| Mar. 9–10 | 7–10 | A | 14D | | $19^{14}$ |
| Mar. 22 | 9 | A | 16D | $31^{14}$ | Apr. $1^{6}$ |
| | | | 18D | | $11^{14}$ |
| | | | 19D | | $16^{6}$ |
| Apr. 17–20 | 6–8 | A | 20D | $22^{6}$ | |
| | | | 20E | $23^{19}$ | |
| May | | | 22D | $4^{14}$ | $5^{6}$ |
| | | | 24D | $15^{6}$ | |
| | | | 24E | $15^{19}$ | |
| | | | 26D | $26^{6}$ | |
| | | | 28D | $4^{19}$ | |
| | | | 28E | $5^{14}$ | |
| June 6–11 | 5–7 | N | 29D | $10^{19}$ | |
| | | | 29E | $13^{6}$ | |
| June 18 | 8–10 | N | 31D | $22^{14}$ | |
| July 3–4 | 6–7 | N | 33D | $4^{14}$ | $5^{6}$ |
| | | | 33E | $5^{14}$ | $6^{14}$ |
| July 9–11 | 6–8 | N | | | |
| Aug. 11 | 6 | N | 41D | $15^{6}$ | |
| | | | 41E | $16^{14}$ | |
| Aug. 19–20 | 5–6 | A., N. | | | |
| Aug. 28–29 | 6–7 | N | 45D | Sept. $5^{19}$ | |
| Sept. 8–10 | 6–8 | A | | | |
| | | | 50D | $2^{6}$ | $2^{19}$ |
| Oct. 6–7 | 6–9 | A | 51D | $8^{6}$ | |
| | | | 51E | $8^{14}$ | |
| | | | 54D | | $25^{19}$ |
| | | | 54E | | $27^{6}$ |
| Nov. 7–10 | 6–7 | A | 58D | $13^{6}$ | |
| Nov. 10–12 | 7–9 | M | 58E | | $14^{6}$ |
| Nov. 11–12 | 7–8 | N | 59D | | $19^{6}$ |
| Nov. 16–18 | 5–6 | M | 59E | | $20^{6}$ |
| Nov. 19–20 | 5–9 | A., N. | | | |
| Nov. 20 | 9 | A | | | |
| Nov. 21–23 | 6–8 | M | 61D | $30^{19}$ | Dec. $4^{6}$ |
| | | | 61E | | $5^{14}$ |
| | | | 62D | $11^{19}$ | |
| | | | 62E | $12^{19}$ | |
| Dec. 19–20 | 6–9 | A., N. | 63D | $20^{6}$ | |
| Dec. 22–24 | 8–9 | A | 65D | $27^{6}$ | |
| Dec. 19–26 | 6–7 | N | | | |
| Dec. 20–25 | 6–10 | M | 66D | $30^{6}$ | |

[1] A, Angmagsalik; N, Nanortalik; M, Mygbugten